TOTAL MAXIMUM DAILY LOAD (TMDL)

For
Fecal Coliform
In
Oak Creek
(WBID 3192C)

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In compliance with the provisions of the Federal Clean Water Act, 33 U.S.C §1251 et. seq., as amended by the Water Quality Act of 1987, P.L. 400-4, the U.S. Environmental Protection Agency is hereby establishing the Total Maximum Daily Load (TMDL) for fecal coliform in Oak Creek (WBID 3192C). Subsequent actions must be consistent with this TMDL.

/s/ 3/29/07

James D. Giattina, Director
Water Management Division

Date

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LIST OF ABBREVIATIONS

AWT	Advanced Waste Treatment
BMP	Best Management Practices
BPJ	Best Professional Judgment
CAFO	Concentrated Animal Feeding Operation
CFS	Cubic Feet per Second
CWA	Clean Water Act
DEM	Digital Elevation Model
DMR	Discharge Monitoring Report
EPA	Environmental Protection Agency
F.A.C.	Florida Administrative Code
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MPN	Most Probable Number
MS4	Municipal Separate Storm Sewer Systems
NASS	National Agriculture Statistics Service
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OSTD	Onsite Sewer Treatment and Disposal Systems
PLRG	Pollutant Load Reduction Goal
Rf3	Reach File 3
RM	River Mile
STORET	STORage RETrieval database
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WBID	Water Body Identification
WLA	Waste Load Allocation
WMP	Water Management Plan

SUMMARY SHEET

Total Maximum Daily Load (TMDL)

1. **303(d) Listed Waterbody Information**
   State: Florida
   Major River Basin: Kissimmee

Impaired Waterbodies for TMDLs (1998 303(d) List):

WBID	Segment Name and Type	River Basin	County	Constituent(s)
3192C	Oak Creek	Kissimmee	Okeechobee	Fecal Coliform

2. **TMDL Endpoints (i.e., Targets) for Class III Waters (fresh and marine):**

Fecal Coliform: The most probable number (MPN) or membrane filter (MF) counts per 100 milliliter (ml) of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period.

3. **Fecal Coliform Allocation:**

WBID	WLA	LA	TMDL	Reduction
3192C	0	38 percent reduction	38 percent reduction	38%

4. **Endangered Species (yes or blank): Yes**

5. **EPA Lead on TMDL (EPA or blank): EPA**

6. **TMDL Considers Point Source, Non-point Source, or both: Non-point Source**

7. **NPDES Discharges to surface waters addressed in TMDLs: None**

TOTAL MAXIMUM DAILY LOAD (TMDL)
FECAL COLIFORM IN OAK CREEK (WBID 3192C)

1. INTRODUCTION

Section 303(d) of the Clean Water Act (CWA) requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not meeting water quality standards. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a waterbody based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water quality based controls to reduce pollution from both point and non-point sources and restore and maintain the quality of their water resources (USEPA, 1991).

The State of Florida Department of Environmental Protection (FDEP) developed a statewide, watershed-based approach to water resource management. Under the watershed management approach, water resources are managed on the basis of natural boundaries, such as river basins, rather than political boundaries. The watershed management approach is the framework FDEP uses for implementing TMDLs. The state's 52 basins are divided into 5 groups. Water quality is assessed in each group on a rotating five-year cycle. The Group 4 basin is shown in Figure 1 and includes the Kissimmee and Fisheating Creek River Basins. The Kissimmee and Fisheating Creek Basins encompass many square miles.

To provide a smaller-scale geographic basis for assessing, reporting, and documenting water quality improvement projects, the FDEP subdivided the Group 4 area into smaller areas called planning units. Planning units help organize information and management strategies around prominent subbasin characteristics and drainage features. To the extent possible, planning units were chosen to reflect subbasins that had previously been defined by the South Florida Water Management District (SFWMD). The Kissimmee and Fisheating Creek Basins contain six planning units: Upper Kissimmee, Lower Kissimmee, Lake Istokpoga, Lake Placid, Northwest Lake Okeechobee, and Fisheating Creek. Oak Creek is in the Lower Kissimmee planning unit.

Water quality assessments were conducted on individual waterbody segments within planning units. Each waterbody segment is assigned a unique waterbody identification (WBID) number. Waterbody segments are the assessment units or polygons that have historically been used by the FDEP to define waterbodies in their biannual inventory and reporting of water quality to EPA under Section 305(b) of the federal CWA. The same WBIDs are also the assessment units identified in the FDEP's biannual lists of impaired waters submitted to EPA as part of their reporting under Section 303(d) of the CWA.

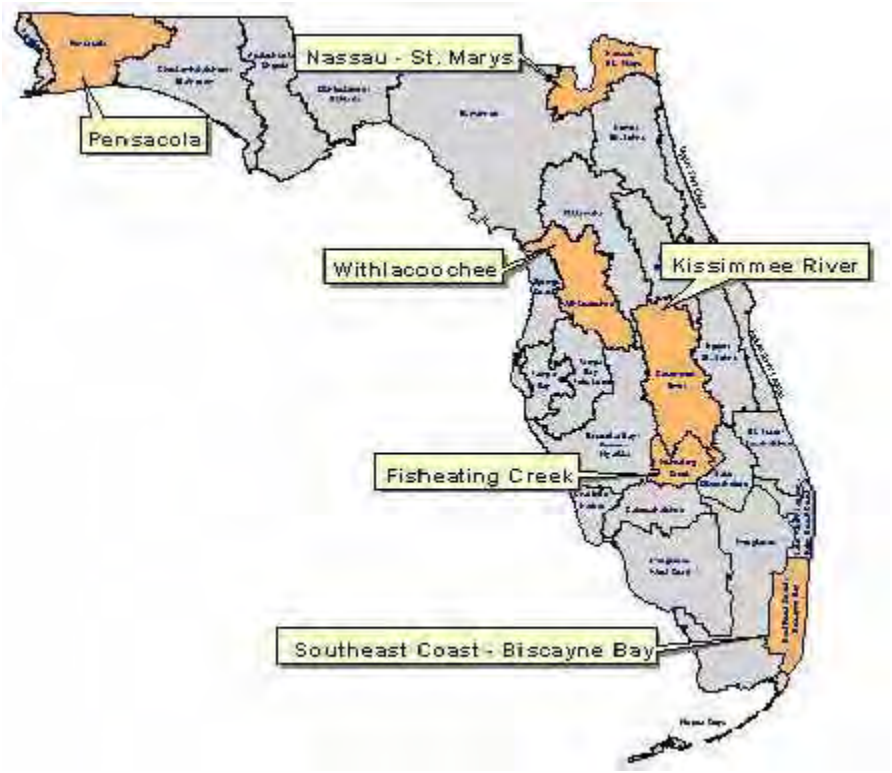

Figure 1: FDEP Group 4 River Basins.

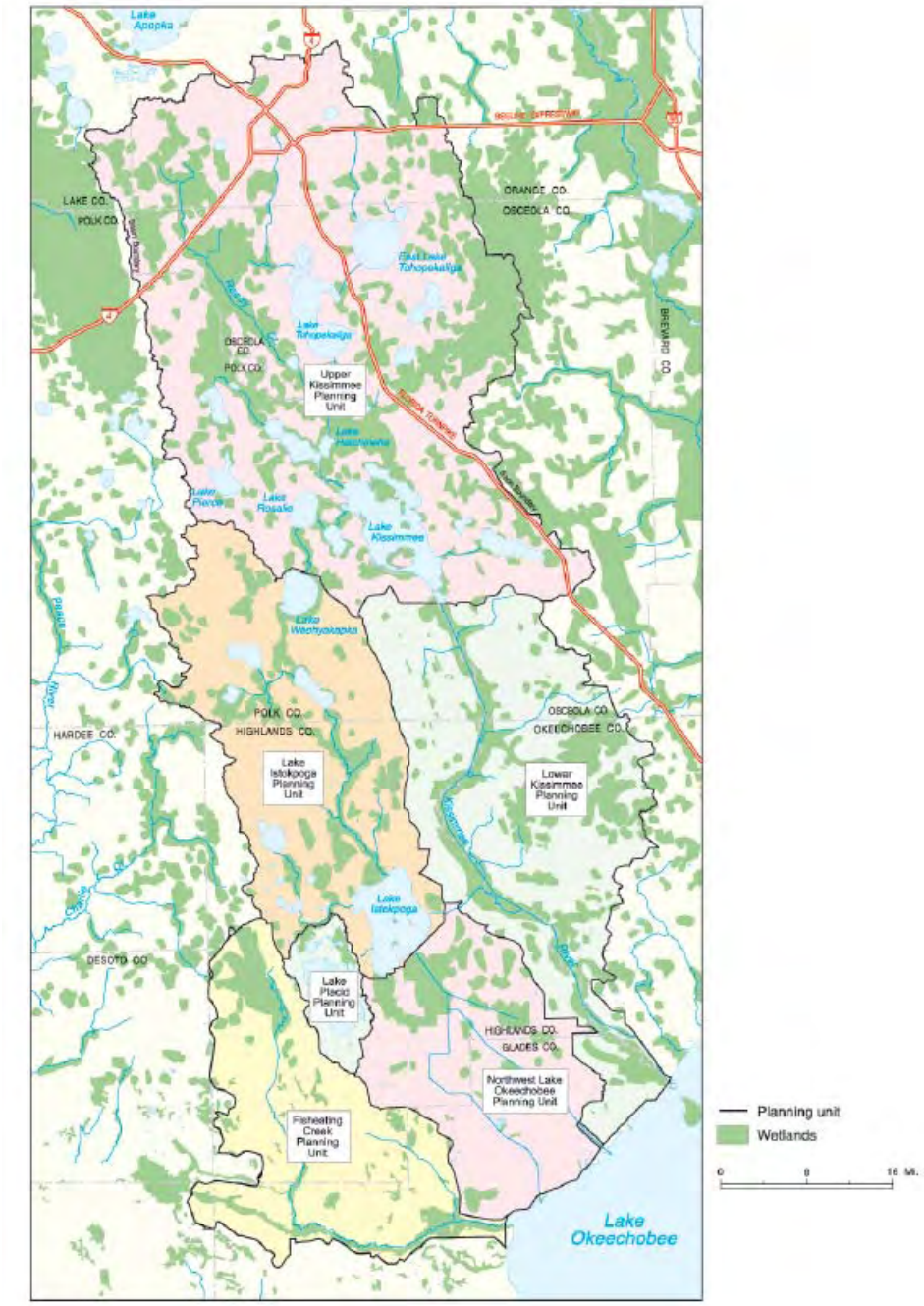

Figure 2: Planning Units in the Kissimmee and Fisheating Creek River Basins.

2. PROBLEM DEFINITION

Florida's final 1998 Section 303(d) list identified Oak Creek, WBID 3192C, in the Kissimmee River Basin as not supporting water quality standards (WQS) due to coliform bacteria. The location of WBID 3192C is shown in Figure 2. After assessing all readily available water

quality data, EPA is responsible for developing a fecal coliform TMDL for the creek. This TMDL is being established pursuant to EPA commitments in the 1998 Consent Decree in the Florida TMDL lawsuit (Florida Wildlife Federation, et al. v. Carol Browner, et al., Civil Action No. 4: 98CV356-WS, 1998).

Oak Creek is designated a Class III fresh water. The designated use of Class III waters is recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife. Class III waters are further categorized based on fresh or marine waters. Water quality criteria for fecal coliform do not vary between Class III fresh or marine waters.

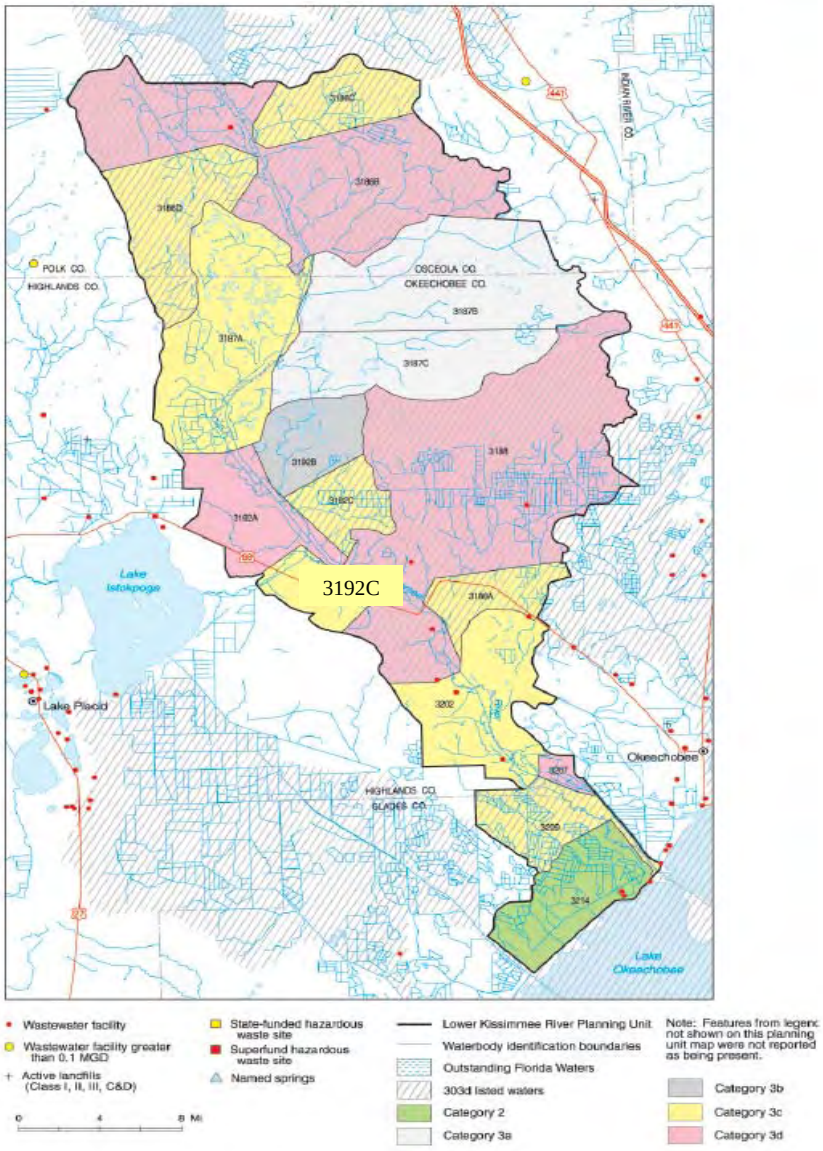

Figure 3: Lower Kissimmee Planning Unit

3. WATERSHED DESCRIPTION

The following information is from FDEP's Water Quality Status Report for Kissimmee River and Fisheating Creek (FDEP, 2004) and the Oak Creek Ecosummary Report (FDEP, 2000). The 722 square-mile Lower Kissimmee planning unit encompasses portions of Polk, Osceola, Highlands, and Okeechobee Counties. Significant waterbodies include the Kissimmee River (C-38) and its tributary watersheds between the outlet of Lake Kissimmee and Lake Okeechobee. This planning unit also receives flow from the Istokpoga planning unit via the Istokpoga Canal and the C-41A Canal. There are no significant named communities in this planning unit, as the area is entirely rural in nature. About half of the 106,110-acre Avon Park Air Force Range (an active military bombing test range) is located in the northern portion of the planning unit, along the Polk-Highlands County line. Land uses in this planning unit are dominated by cattle grazing, wetlands, forestry, military, and a few citrus groves in higher spots. Land use in the Oak Creek watershed is provided in Table 1 and is consistent with the historic land use distribution in the basin, primarily farming and cattle ranching.

Oak Creek is located in western Okeechobee County and flows to a natural oxbow of the Kissimmee River. Historically, Oak Creek was a natural wetland slough that merged with the unchannelized Kissimmee River. Between 1962 and 1970 the Kissimmee River was channelized in attempts to prevent catastrophic flooding and improve navigation. After the Kissimmee River was channelized, Oak Creek was channelized in the 1970's by private land owners. Oak Creek is located on Pool C of the Kissimmee River. Pools on the Kissimmee River are the result of water held back by control structures. Pool C is the first part of the Kissimmee River Restoration Project and is now being backfilled along with a half mile stretch of the man-made channel of Oak Creek at its western end. The remaining portion of Oak Creek remains channelized. The SFWMD and the U.S. Army Corps of Engineers (USCOE) are unable to fill Oak Creek any further because it would interfere with land in private ownership (FDEP, 2000).

Table 1: Land Cover Distribution for WBID 3192C in acres and percentage.

Land Cover	Acreage	Percentage
Residential (1100-1390)	0	0%
Commercial, Industrial, Public (1400, 1500, 1800)	0	0%
Agriculture (2000 series)	8784	85%
Rangeland (3000 series)	0	0%
Forest (4000 series)	0	0%
Water (5000 series)	0	0%
Wetlands (6000 series)	1551	15%
Barren & Extractive (7000, 1600)	0	0%
Transportation & Utilities (8000 series)	0	0%
TOTAL (acres)	10335	

4. WATER QUALITY STANDARD FOR FECAL COLIFORM BACTERIA AND TARGET IDENTIFICATION

The water quality criteria for protection of Class III waters are established by the State of Florida in the Florida Administrative Code (F.A.C.), Section 62-302.530. The individual criteria should be considered in conjunction with other provisions in water quality standards, including Section 62-302.500 F.A.C. [Surface Waters: Minimum Criteria, General Criteria] that apply to all waters unless alternative or more stringent criteria are specified in F.A.C. Section 62-302.530.

Fecal coliforms are a subset of the total coliform group and indicate the presence of fecal material from warm-blooded animals. Total coliform bacteria generally indicate the presence of soil-associated bacteria and result from natural influences on a water body such as rainfall runoff as well as sewage inflows. The most probable number (MPN) or membrane filter (MF) counts per 100 milliliter (ml) of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day. Monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. The geometric mean criteria reflect chronic or long-term water quality conditions whereas the 400 and 800 values reflect acute or short-term conditions.

The target for this TMDL is the daily 800 MPN/100 ml and the "not to exceed 400 in 10 percent of the samples" criteria, since enough monthly data was not collected to evaluate the monthly average 200 MPN/100 ml criterion. When flow data are available in the WBID, the fecal coliform TMDLs are expressed as daily loads in units of MPN per day. The fecal coliform TMDLs are also expressed in terms of the percent reduction required to achieve water quality standards. When flow data are not available in the WBID or it is not possible to estimate flow due to hydrologic and/or geologic conditions (i.e., tidal influence or karst geologic formation), the TMDLs are expressed only as percent reductions.

It is appropriate to use the more stringent of the acute criteria for fecal coliform TMDL development as the data indicate violations of the standard are typically related to storm events, which are short-term in nature. Violations of the chronic criteria are typically associated with point sources or non-point source continuous discharges (e.g., leaking septic systems) and typically occur during all weather conditions. Targeting the acute criteria will be protective of the chronic criteria.

5. WATER QUALITY ASSESSMENT

To determine the status of surface water quality in Florida, three categories of data – chemistry data, biological data, and fish consumption advisories – were evaluated to determine potential impairments. The level of impairment is defined in the Identification of Impaired Surface Waters Rule (IWR), Section 62-303 of the Florida Administrative Code (F.A.C.). The IWR

defines FDEP's threshold for identifying water quality limited WBIDs to be included on the State's 303(d) list. In addition, all waters on the 1998 303(d) list that were not de-listed remain on the current 303(d) list and require TMDLs. WBID 3192C is on FDEP's planning list for fecal coliform bacteria. EPA assessed this WBID and concluded that it is impaired, and a fecal coliform TMDL must be developed.

FDEP maintains ambient monitoring stations throughout the basin. All data collected at monitoring stations within the impaired WBID are used in the analysis, and are included in Appendix A. Table 2 provides a list of the monitoring stations and the number of coliform samples collected. Table 3 shows a statistical summary of the data. Only two observations were above the standard of 400 MPN/100 ml and none were above 800 MPN/100 ml. There is no clear relationship between rainfall and fecal coliform concentrations since high coliform occurred after no rainfall as well as after rainfall (see Figure 4). Also, low coliform concentrations were observed after the largest measured rainfall.

Table 2: Monitoring Stations used in the Development of this Fecal Coliform TMDL.

Station ID	Station Name	Number of Observations
21FLFTM 6010731FTM	OAK CREEK WBID 3192C SITE 1	9
21FLFTM 6010732FTM	OAK CREEK WBID 3192C SITE 2	2

Table 3. Summary of Fecal Coliform Monitoring Data in WBID 3192C.

Number of Samples	30-Day Geometric Mean[1]	% Samples > 400 (MPN/100ml)	% Samples > 800 (MPN/100ml)	Minimum Concentration (MPN/100ml)	Maximum Concentration (MPN/100ml)
11	N/A	18%	0%	10	640

Notes:

1. N/A = not applicable since less than 10 samples were collected within a 30-day period to evaluate criteria.

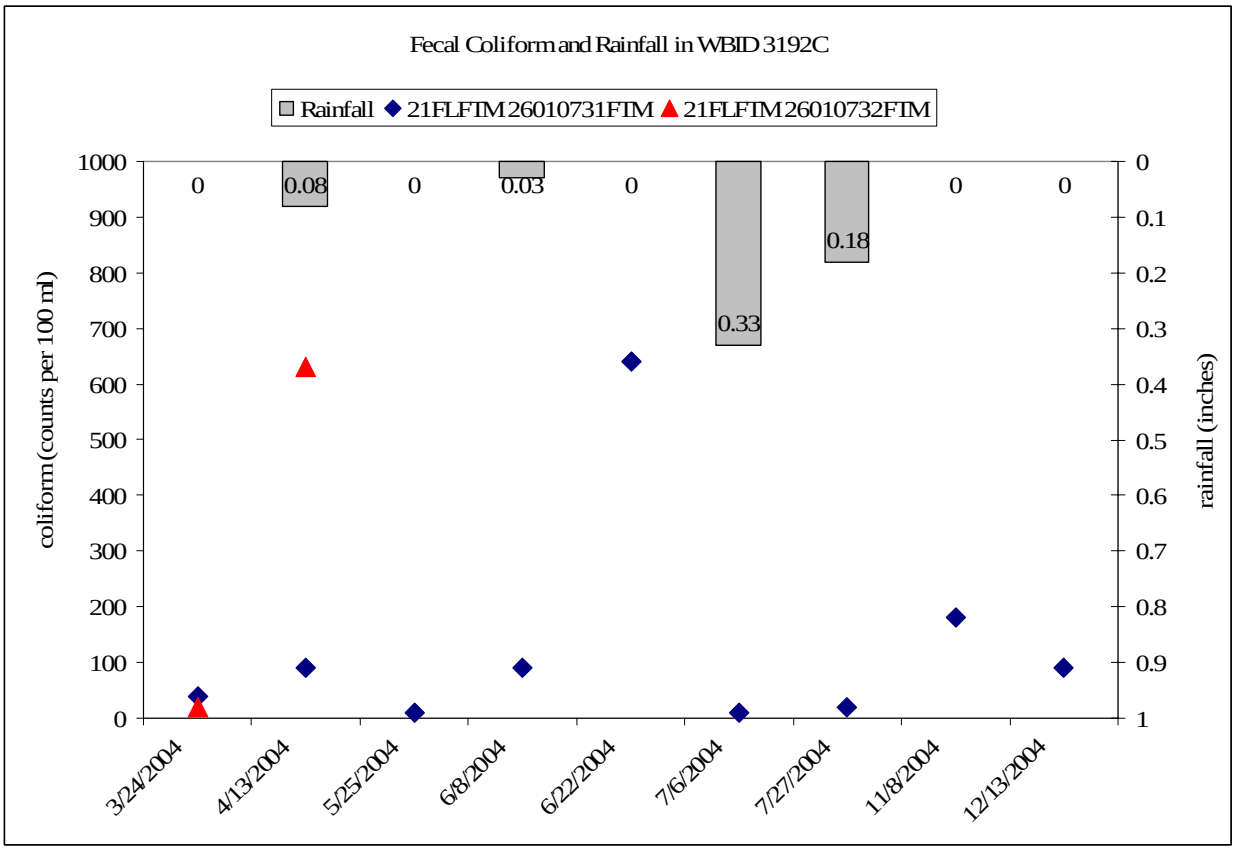

Figure 4: Fecal Coliform and Rainfall Data in WBID 3192C.

6. SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of source categories, source subcategories, or individual sources of pollutants in the watershed and the amount of loading contributed by each of these sources. Sources are broadly classified as either point or non-point sources. Fecal coliforms enter surface waters from both point and non-point sources.

A point source is defined as a discernable, confined, and discrete conveyance from which pollutants are or may be discharged to surface waters. Point source discharges of industrial wastewater and treated sanitary wastewater must be authorized by National Pollutant Discharge Elimination System (NPDES) permits. NPDES permitted facilities also include certain urban stormwater discharges such as municipal separate stormwater systems (MS4 areas), certain industrial facilities, and construction sites over one acre that are stormwater driven point sources. NPDES permits are also required for concentrated animal feeding operations (CAFOs).

Non-point sources of pollution are diffuse sources that cannot be identified as entering a waterbody through a discrete conveyance at a single location. These sources generally, but not

always, involve accumulation of bacteria on land surfaces that wash off as a result of storm events. A geographic information system (GIS) tool was used to display, analyze, and compile available information to characterize potential bacteria sources in the impaired WBID. This information includes land use, point source dischargers, soil types and characteristics, population data (human and livestock), and stream characteristics.

6.1 Point Sources

A wasteload allocation (WLA) is given to all NPDES facilities in the watershed permitted to discharge to surface waters. Under the NPDES program, permits for wastewater facilities may authorize a discharge only if the applicant provides reasonable assurance that the discharge will not cause or contribute to violations of the water quality criteria. There are no wastewater or industrial NPDES facilities in the Oak Creek watershed permitted to discharge to surface waters.

Municipal Separate Storm Sewer Systems (MS4s) may also discharge fecal coliforms to waterbodies in response to storm events. Large and medium MS4s serving populations greater than 100,000 people are required to obtain a NPDES storm water permit under the Phase I storm water regulations. After March 2003, small MS4s serving urbanized areas were required to obtain a permit under the Phase II storm water regulations. An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile. The Oak Creek watershed is located entirely in Okeechobee County and there are no municipalities in the watershed of sufficient population or density requiring MS4 permits.

CAFOs are point sources, as defined by the CWA [Section 502(14)]. To be considered a CAFO, a facility must first be defined as an Animal Feeding Operation (AFO). Animal feeding operations are agricultural operations where animals are kept and raised in confined situations. AFOs generally congregate animals, feed, manure, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures. Animal waste and wastewater can enter creeks from spills or breaks of waste storage structures (due to accidents or excessive rain), and non-agricultural application of manure to crop land. CAFOs are known to operate in Okeechobee County and could be in the Oak Creek watershed, as the surrounding land use of Oak Creek has historically dominated by cattle ranches (FDEP, 2000). CAFOs, if any, have a no discharge permit, and if operating in accordance with permit requirements, should not cause or contribute to fecal coliform impairment.

6.2 Non-point Sources

Typical non-point sources of fecal coliform include wildlife, agricultural animals, septic tanks, and urban development outside of MS4 areas. Non-point source pollutant loads typically occur in response to rain events, but animals having access to streams and leaking septic tanks can result in non-point source loads during dry weather conditions. Based on landuse information provided in Table 1, the categories most likely associated with the non-point source discharges

of fecal coliform in the Oak Creek watershed would be agriculture, including animals having access to streams. Agriculture landuse comprises 85 percent of the WBID. A general discussion of septic tanks and the impact malfunctioning ones have on water quality is included in this source assessment, but are not considered a significant source due to the negligible amount of urban landuse in the watershed (see Table 1).

6.3 Wildlife

Wildlife deposit bacteria in their feces onto land surfaces where it can be transported during storm events to nearby streams. Bacteria load from wildlife is assumed background, since this source is considered "natural" when compared to the loading from agriculture. Water fowl (e.g., egrets, ducks, wood storks, herons) often frequent stormwater ponds and wetland areas surrounding the creek. Wetland areas that provided critical habitat for migratory water fowl were lost when Oak Creek was channelized in the 1970s. FDEP reports migratory water fowl populations have declined as cattle ranchers and dairy farms cleared vast tracts of native vegetation in order to create improved pasture (FDEP, 2000).

6.4 Agricultural Animals

Agricultural animals are the source of several types of coliform loadings to streams that impact water quality. This source includes agriculture runoff from pastures and cattle in streams. Landuse within the Oak Creek watershed is predominately agricultural, so this landuse likely produces a significant amount of the bacteria load.

The USDA National Agricultural Statistics Service (NASS) compiles Census of Agriculture data by county for virtually every facet of U.S. agriculture (USDA, 2002). The "Census of Agriculture Act of 1997" (Title 7, United States Code, Section 2204g) directs the Secretary of Agriculture to conduct a census of agriculture on a 5-year cycle collecting data for the years ending in 2 and 7. In 2002, NASS reported 392,495 farmland acres in Okeechobee County. Livestock inventory from the 2002 Census of Agriculture reports for Okeechobee County is listed in Table 4. Cattle and calves are the predominate livestock.

Table 4. Livestock Inventory by County (source: NASS, 2002).

Livestock (inventory)	Okeechobee
Cattle and calves	142,656
Hogs and Pigs	82

6.5 Onsite Sewerage Treatment and Disposal Systems (Septic Tanks)

Onsite sewage treatment and disposal systems (OSTDs) including septic tanks are commonly used where providing central sewer is not cost effective or practical. When properly sited, designed, constructed, maintained, and operated, OSTDs are a safe means of disposing of domestic waste. The effluent from a well-functioning OSTD is comparable to secondarily treated wastewater from a sewage treatment plant. When not functioning properly, OSTDs can be a source of nutrients, pathogens, and other pollutants to both ground water and surface water. The State of Florida Department of Health publishes septic tanks data on a county basis (www.doh.state.fl.us/environment/ostds/statistics/ostdsstatistics.htm). Table 5 summarizes the cumulative number of septic systems installed since the 1970 census. The data do not reflect septic tanks removed from service.

Table 5. County Estimates of Septic Tank Installations (FDEP, 2004).

County	Number Septic Tanks (1970- 2002)
Okeechobee	11,432

6.6 Urban Development

Fecal coliform loading from urban areas is attributable to multiple sources including stormwater runoff, leaks and overflows from sanitary sewer systems, if present, illicit discharges of sanitary waste, and domestic animals. Based on the landuse distribution in the watershed, there are no significant areas of urban development in the watershed. The contribution of fecal coliform loadings from farms and other rural areas is considered minor relative to the loadings from agriculture.

In 1982, Florida became the first state in the country to implement statewide regulations to address the issue of non-point source pollution by requiring new development and redevelopment to treat stormwater before it is discharged. The Stormwater Rule, as outlined in Chapter 403 Florida Statutes (F.S.), was established as a technology-based program that relies upon the implementation of BMPs that are designed to achieve a specific level of treatment (i.e., performance standards) as set forth in Chapter 62-40, F.A.C. Florida's stormwater program is unique in having a performance standard for older stormwater systems that were built before the implementation of the Stormwater Rule in 1982. This rule states: "the pollutant loading from older stormwater management systems shall be reduced as needed to restore or maintain the beneficial uses of water" (Section 62-4-.432 (5) (c), F.A.C.).

7. Analytical Approach

The approach for calculating coliform TMDLs depends on the number of water quality samples and the availability of flow data. When long-term records of water quality and flow data are not available, the TMDL is expressed as a percent reduction. Load duration curves are used to develop TMDLs when significant data are available to develop a relationship between flow and

concentration. Load duration curves utilize a mass balance approach to estimate loadings transported in the stream. For the load duration curve TMDLs, the target is the acute criteria. Since only 11 water quality measurements were available, this fecal coliform TMDL is expressed as a percent reduction.

7.1 Percent Reduction Approach for TMDL Development

Under this "percent reduction" method, the percent reduction needed to meet the applicable criterion is calculated based on a percentile of all measured concentrations. The (p X 100) percentile is the value with the cumulative probability of p. For example, the 90^{th} percentile has a cumulative probability of 0.90. The 90^{th} percentile is also called the 10 percent exceedance event because it will be exceeded with the probability of 0.10. Therefore, considering a set of water quality data, 90 percent of the measured values are lower than the 90^{th} percentile concentration and 10 percent are higher. Since the water quality standard states the fecal coliform concentration shall not exceed 400 MPN/100 ml in 10 percent of the samples, 400 should be targeted with a percentile slightly larger than 90 to ensure less than 10 percent of the values exceed 400. For this TMDL, 400 MPN/100 ml was targeted as the 95^{th} percentile. This will meet the water quality standard and provide a margin of safety by ensuring that only five percent of the data exceed a concentration of 400 MPN/100 ml. There are many formulas for determining the percentile and these can be found in many text books on statistics. In this TMDL, the Hazen formula was used since it is recommended in Hunter's Applied Microbiology (2002) article concerning bacteria in water. The percent reduction required to meet the coliform criteria is based on the following equation:

Percent Reduction = (existing 95^{th} percentile concentration – criteria) / existing 95^{th} percentile concentration × 100

The 95^{th} percentile concentration is 640 MPN/100ml, and a 38 percent reduction is necessary to meet the water quality target of 400 MPN/100 ml 95 percent of the time. There were no violations of the "not to exceed 800" standard.

8. Development of Total Maximum Daily Loads

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$TMDL = \Sigma WLAs + \Sigma LAs + MOS$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time (e.g. pounds per day), toxicity, or other appropriate measures. The fecal coliform TMDL for the Oak Creek WBID is expressed as a percent reduction.

8.1 Critical Conditions

The critical condition for non-point source coliform loading is an extended dry period followed by a rainfall runoff event. During the dry weather period, coliforms build up on the land surface, and are washed off by rainfall. The critical condition for point source loading occurs during periods of low stream flow when dilution is minimized. Water quality data have been collected during both time periods. Most violations occur during median to high flow conditions. Critical conditions are accounted for in the analyses by using the entire period of record of measured flows (when available) and all water quality data available for the WBID.

8.2 Margin of Safety

TMDLs shall include a margin of safety that takes into account any lack of knowledge about the pollutant loading and in-stream water quality. In this case the measured water quality was used directly to determine the reduction to meet the water quality standard. In this case the lack of knowledge concerns the data, and how well it represents the true water quality. There are two methods for incorporating a MOS in the analysis: 1) implicitly incorporate the MOS using conservative model assumptions to develop allocations; or 2) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In this TMDL, an implicit MOS was used by targeting reductions that will result in no more than five percent of the samples exceeding a concentration of 400 MPN/100 ml even though the water quality standard is less stringent and requires less than 10 percent exceedance.

8.3 Determination of TMDL, LA and WLA

The TMDL values represent the maximum daily load the stream can assimilate and maintain water quality standards. The TMDL is based on not exceeding 400 MPN/100ml and is expressed as a percent reduction. TMDL components required to achieve the numerical criterion are summarized in Table 6.

Table 6. Summary of TMDL Components

Stream Name / WBID	Parameter	WLA	LA	TMDL
Oak Creek (3192C)	Fecal Coliform	0	38% reduction	38% reduction

8.4 Waste Load Allocations

There are no wastewater or industrial NPDES facilities discharging to surface waters in the Oak Creek watershed; however, CAFOs are known to operate in the county. NPDES permits for CAFOs do not allow discharges to surface waters. The WLA assigned to Oak Creek is zero.

8.5 Load Allocations

There are two modes of transport for non-point source coliform bacteria loading into the stream. First, fecal coliform loading from failing septic systems and animals in the stream are considered direct sources of coliform to the stream, since they are independent of precipitation. The second mode involves coliform loadings resulting from accumulation on land surfaces transported to streams during storm events. Eleven measurements were made in the Oak Creek WBID from two different water quality monitoring stations. There were two observations above 400 MPN/100 ml, and one occurred after rainfall and the other with no rainfall. Thus, according to these data, the load allocation of 38 percent reduction should target both types of sources.

8.6 Seasonal Variation

Seasonality was addressed by using all water quality data associated with the impaired WBID, which was collected during multiple seasons.

8.7 Recommendations

Determining the source of bacteria in waterbodies is the initial step to implementing a coliform TMDL. FDEP employs the Basin Management Action Plan (B-MAP) as the mechanism for developing strategies to accomplish the necessary load reductions. Components of a B-MAP are:

- Allocations among stakeholders,
- Listing of specific activities to achieve reductions,
- Project initiation and completion timeliness,
- Identification of funding opportunities,
- Agreements,
- Local ordinances,
- Local water quality standards and permits, and
- Follow-up monitoring.

9. REFERENCES

Cleland, Bruce, 2003. *TMDL development from the "bottom up" – Part III: Duration curves and wet-weather assessments.* America's Clean Water Foundation, Washington, DC. September 15, 2003.

Florida Administrative Code (F.A.C.). Chapter 62-302, Surface Water Quality Standards.

Florida Department of Environmental Protection (FDEP), 2000. Ecosummary Oak Creek Okeechobee County. FDEP Southeast District Surface Water Quality Section, Port St. Lucie, FL. December 2000.

FDEP. 2004. *Water Quality Status Report, Kissimmee River and Fisheating Creek Basin,* FDEP Division of Water Resource Management, Group 4 Basin, 2004.

P.R. Hunter. 2002. The Society for Applied Microbiology, Letters in Applied Microbiology. 34. 283–286.

USDA, 1997. *1997 Census of Agriculture, Volume 1, Geographic Area Series, Part 42,* U.S. Department of Agriculture, National Agricultural Statistics Service. AC97-A-42, March 1999.

USDA, 1997. *2002 Census of Agriculture, Volume 1, Geographic Area Series, Part 9,* U.S. Department of Agriculture, National Agricultural Statistics Service. AC02-A-9, June 2004.

USEPA, 1991. *Guidance for Water Quality –based Decisions: The TMDL Process.* U.S. Environmental Protection Agency, Office of Water, Washington, DC. EPA-440/4-91-001, April 1991.

APPENDIX A: Fecal Coliform Data

Table 7: Guide to Water Quality Remark Codes (Rcode column in data tables).

Remark Code	Definition	Use in TMDL
A	Value reported is mean of two or more samples	Data included in analysis as reported
B	Result based on colony counts outside the acceptable range	Data included in analysis as reported
E	Extra sample taken in compositing process	Data included as average
I	The value reported is less than the practical quantification limit and greater than or equal to the method detection limit.	Data included in analysis as reported
J	Estimated. Value shown is not a result of analytical measurement.	Data included in analysis as reported
K	Off-scale low. Actual value not known, but known to be less than value shown	Data included in analysis as reported
L	Off-scale high. Actual value not known, but known to be greater than value shown	Data included in analysis as reported
Q	Sample held beyond normal holding time	Data used in analysis – holding samples on ice slows the metabolism of the organisms resulting in no appreciable growth. Actual concentration is expected to be at least as high as the value reported.
T	Value reported is less than the criteria of detection	Data included in analysis if the reported value is below criteria; otherwise, reported value is not used in the analysis
U	Material was analyzed for but not detected. Value stored is the limit of detection.	Data not included in analysis
<	NAWQA – actual value is known to be less than the value shown	Data included in analysis
Z	Too many colonies were present to count (TNTC), the numeric value represents the filtration volume	Data not included in analysis

Table 8. Fecal Coliform Data and Percentile Calculations

Date	Time	Station	Result	Rank	Percentile by Hazen method
5/25/2004	1320	21FLFTM 26010731FTM	10	1	5%
7/6/2004	1130	21FLFTM 26010731FTM	10	2	14%
7/27/2004	1200	21FLFTM 26010731FTM	20	3	23%
3/24/2004	1225	21FLFTM 26010732FTM	20	4	32%
3/24/2004	1155	21FLFTM 26010731FTM	40	5	41%
6/8/2004	1211	21FLFTM 26010731FTM	90	6	50%
4/13/2004	1315	21FLFTM 26010731FTM	90	7	59%
12/13/2004	1325	21FLFTM 26010731FTM	90	8	68%
11/8/2004	1420	21FLFTM 26010731FTM	180	9	77%
4/13/2004	1345	21FLFTM 26010732FTM	630	10	86%
6/22/2004	1344	21FLFTM 26010731FTM	640	11	95%

There are many formulas for determining the percentile and these can be found in many text books on statistics. In this TMDL the Hazen formula was used since it is recommended in Hunter's Applied Microbiology (2002) article concerning bacteria in water.